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Soviet Genetic-Engineering Capabilities [redacted]

Scientific and Technical Intelligence Committee

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Soviet Genetic-Engineering Capabilities [redacted]

This report was approved by the Scientific and Technical Intelligence Committee on 10 November 1983.

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Soviet Genetic-Engineering Capabilities [redacted]

Key Judgments

The Soviets have a large centrally directed program to promote biotechnology in general and genetic engineering in particular. As with many other industrialized nations, the Soviets look to genetic engineering for solutions to problems in the defense industry, agriculture, and public health.

We believe that a critical area of dissimilarity between US and USSR genetic engineering R&D programs is the greater level of Soviet effort devoted to military applications. If their programs have been successful they constitute a significant threat. In most other respects, Soviet achievements will tend to be similar to those of the West.

Within the next two to five years, those significant applications of Soviet genetic engineering that seem most likely are the export licensing of patented organisms for the fermentation industry, the production of biologically active substances for human medicine, and the creation of enhanced or unique CW/BW agents.

Although the Soviets have been innovative in some of the scientific disciplines that form the foundation for genetic engineering, their overall effort and level of contribution in basic research lags that of the United States and the West European nations. They are product oriented and can be expected to continue emphasizing applications-oriented research.

The broad goals for Soviet applied biotechnology have been published [redacted] At present, assessments of Soviet success potential must be inferred largely from what is believed to be their national priorities, the traditional strengths of their scientific and technical establishment, and the current state of the art.

The Soviets intend to compete in international economic markets, most likely through sale of products or licensing of processes. Success in this area has potential for improving the USSR's foreign exchange earnings position. However, they are not expected to match the West in the diversity of commercially useful applications.

The key to the Soviet's genetic-engineering technology base development has been the transfer of applicable technology from the West. They are striving for greater self-sufficiency, but dependence on foreign materials and processes will remain significant. The international network of suppliers that supports genetic-engineering R&D is extensive. Because of this, efforts to curtail US technology transfer would not significantly impede Soviet progress.

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Soviet Genetic-Engineering Capabilities [redacted]

Introduction

Genetic engineering is currently the most publicized aspect of a wide spectrum of new biotechnical capabilities that are emerging from genetics, microbiology, and biochemistry laboratories around the world. Research initiatives taken in the leading institutions of the United States, Western Europe, [redacted] are being quickly exploited in applied sciences such as medicine, chemical production, and agriculture. Genetic engineering has been compared to semiconductor technology, atomic energy, and space travel in terms of its potential to bring about technological change. [redacted]

Deoxyribonucleic acid (DNA) is the information-carrying component of genetic material in the cells of all living things. As these cells grow, the information encoded in their DNA directs the biochemical processes that support life. When cells reproduce, copies of that DNA are passed to the next generation. Recombinant DNA (rDNA), often called gene splicing, is a method by which genetic material can be isolated, manipulated, and introduced into cells to bring about changes in their biochemical processes. One major application is expected to be the large-scale production of compounds previously available in only very small quantities. Recombinant DNA is the process directly responsible for the production of human insulin and other medically useful substances by genetically modified micro-organisms [redacted]

The rDNA techniques for manipulating genetic material were pioneered in 1973. At that time, the gene manipulation concept attracted considerable attention because of concerns about the potential for harm to humans and the environment. In 1975 scientists from many countries met in Asilomar, California to determine the magnitude of the hazard and to establish basic safety measures and standards of laboratory practice for rDNA research. At first, the guidelines were quite restrictive and several categories of experiments were prohibited. As practical experience with the techniques was gained, the guidelines were extensively revised to make them less stringent. However, certain types of experiments have remained on the forbidden list and are likely to remain so. For example, the creation of a recombinant based on DNA from a diphtheria causing bacteria and DNA from a harmless bacteria capable of living in the human intestine is prohibited. Such a combination might result in the creation of a dangerous pathogen. Since their inception, the guidelines for US rDNA research have been binding only on government supported work although they have served as a model for nongovernment-sponsored research in the United States and for guidelines adopted by other countries. [redacted]

Indications of Soviet interest in rDNA were apparent in the mid-1970s. They sent participants to Asilomar and to subsequent meetings having to do with the guidelines formulation process. In 1976, Yuriy A. Ovchinnikov, one of the leading Soviet biotechnologists and a Vice President of the Soviet Academy of Sciences, urged the USSR's prominent molecular biologists to pave the way for Soviet genetic engineering research. By 1978 the Soviets were methodically collecting information and materials to broaden their genetic-engineering technology base. Western laboratories hosted Soviet scientists, and students were sent to the West for extended post-doctoral research programs. These hands-on practical experiences together with an extensive program of Western equipment and materials purchases by the USSR resulted in a substantial transfer of rDNA technology. Concurrently, Soviet-authored basic rDNA research reports were becoming more frequent in Soviet and international journals. [redacted]

The Soviet Government is currently promoting genetic engineering. A stated goal of the Communist Party of the Soviet Union (CPSU) Central Committee and the USSR Council of Ministers is that "biotechnology should promote a further deepening of theoretical

research and increase the scales of production and extend the range of preparations for medicine, agriculture and industry." The Soviets have acknowledged that the most immediately promising area in biotechnology is genetic engineering. To further this goal, the Soviets established an Interagency Scientific Technical Council in 1981. This Council, able to cross ministry and academy lines of responsibility, was charged with providing scientific leadership and the coordination of derived industrial applications. Currently, at least 70 institutes affiliated with a broad range of academies and ministries, have been identified with genetic-engineering-related research programs. Of notable interest are indications that the Soviets are stimulating application-oriented genetic-engineering research by promoting capitalistic incentives and are intending to compete in international economic markets [redacted]

The Soviet military is contributing support to the development of this technology. Because there are a broad range of potential militarily related genetic-engineering applications, the threat of technological surprise must be carefully assessed. Although military involvement in basic research is apparent, attempts to determine the objectives and extent of military R&D in this area are just beginning [redacted]

Characterization of the Soviet Genetic-Engineering Effort

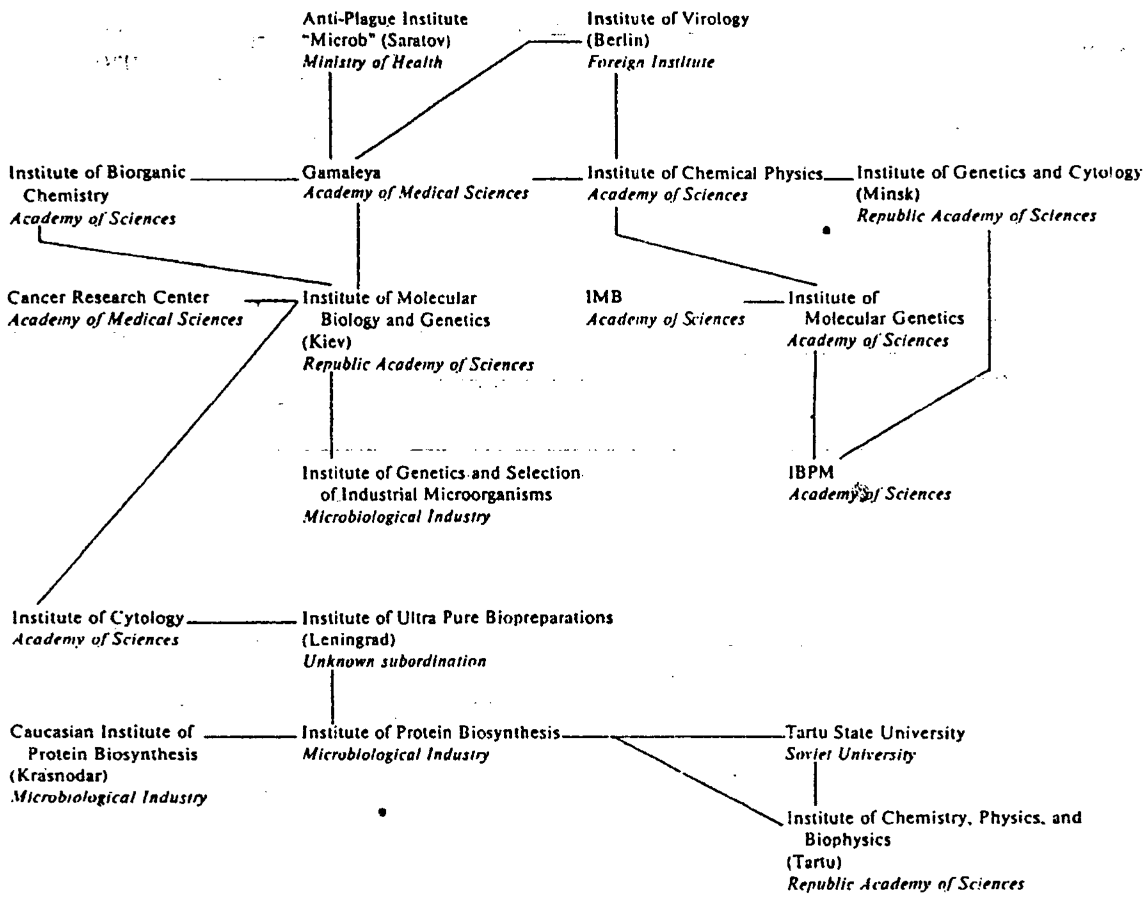
Growth and Expansion. Historically, with a few exceptions, the Soviet scientific community has not been noted for important contributions in biological and biomedical sciences. The Soviet genetic-engineering effort was started during the mid-1970's and, as in other biological sciences, researchers have not been among the innovators. The program was first noted when several researchers from a few Soviet institutes began publishing recombinant DNA genetics articles in Soviet scientific journals. Initial experiments were fundamental in nature repeating published, successful work previously completed in the West. The early years of genetic-engineering research are best characterized by sincere international cooperation between scientists. Without doubt, the free flow of information in the open literature and the direct communications process between scientists provided the impetus for existing programs in participating countries. The Intelligence Community was aware of Soviet visits to US and European laboratories engaged in genetic-engineering research. Because of their late entry in this technology, they benefited greatly from the visits and other exchanges of information. [redacted]

Soviet interest became more evident during 1976, when, at a meeting of molecular biologists in Moscow, the USSR's most prominent molecular biologists and geneticists were urged to further their country's rapid progress in the field. Their progress is marked by the subsequent Soviet expansion of institutes and personnel involved in genetic-engineering research. Much of their published research was still basic; however, their studies were increasingly targeted toward programs with applications potential. Soviet studies represent diverse efforts directed toward gene isolation or synthesis, insertion of recombinant-DNA containing vectors into host cells, studying conditions and methods necessary for optional production of gene products, and recovering cell lines with desired gene expressions. Basic research will remain fundamental to new discoveries and Soviet successes will be measured by the dedication of resources, and the serendipitous finding of useful genes with applications potential.

[redacted]

Coordination. In 1981 the President of the Soviet Academy of Sciences, Anatoly P. Aleksandrov, told the 26th Congress of the Soviet Communist Party that it was time to create a full-fledged ministry of biotechnology industry. Such a ministry has not been established. A compromise, by joint resolution of the CPSU Central Committee and the USSR Council of Ministers, may have been the formation of an Interagency Scientific Technical Council. This Council, subordinate to the State Committee for Science and Technology (GKNT) and the Presidium of the USSR Academy of Sciences, appears to have been given broad responsibilities. Its function is to organize and stimulate biotechnology-related research programs and to coordinate program-derived applications with Soviet industry. The Council's specific responsibilities probably include: establishing research priorities, research tasking, coordinating collaborative efforts between institutes (figure 1), evaluating research results,

Soviet Collaborative Research



[redacted]

and coordinating the training of participating scientists. The 1982 Tallinn Plasmids Symposium was sponsored by this Council. Because the Soviet genetic-engineering effort transcends so many ministries and scientific academies, it is certain that the total program is centrally orchestrated at a high national level. [redacted]

Better knowledge of official policies and regulations governing Soviet genetic engineering research would benefit US intelligence analysts in determining Soviet research objectives and likely success potential. Although Soviet officials publicly claim adherence to

Table 1
Soviet Applied Research Efforts

Microbial leaching of metals from ore.
Removal of methane from coal deposits.
Development of microbial insecticides.
Development of synthetic insulin, interferon, somatotropin and other biologically active human proteins.
Biodegradation of naphthalene, synthetic polymers, pesticides, and other substances that resist natural decomposition.
Biodegradation of oil (to clean up oil spills, residual oil in tank holds, and so forth).
Production of viral coat proteins and glycoproteins for vaccine development.
Hydrogen production.
Nitrogen fixation.
Production of food and food additives, enzymes for industrial use, and so forth.
Antibiotic production.
Research of human genetics problems, hereditary diseases, and so forth.
Microbially enhanced oil recovery.
Production of biologically active peptides, for example, sleep-inducing peptide.
Synthetic fuel development.
Development of bacterial fermentation mechanisms.
Bacterial production of amino acids.

[redacted]

international guidelines and safety standards that have been established for genetic engineering research, we believe that the Soviets will follow only those guidelines and safety measures that will serve their purpose. We do not assume that they will follow set restrictions on pathogenic (disease-causing) organism research. Because of the USSR's apparent interest in international marketing of products and licensing, they will probably respect foreign patent rights in their export trade. However, this confidence does not extend to products for internal consumption[redacted]

Soviet Applied Research. The Soviets are clearly committed to applied research. They look to genetic engineering for solutions to problems ranging from agriculture and industry to public health. Applications-directed research (table 1) is seen in agriculture, medicine, pharmaceutical and chemical industries, and biodegradation. Other applied research efforts, not yet identified, are also likely. Success in applied genetic engineering is dependent upon the discovery or identification of gene coding for biologically active products. In the West, initial rDNA successes have occurred leading to the production of human blood proteins, endogenous hormones, and the identification of specific synthetic antigens vital to superior vaccine development. Fundamental discoveries in this field are most often labor intensive, and this methodology has often served the USSR scientific community well. We believe that most of the Soviet talent and resources will be directed at applied research built upon basic discoveries published by workers elsewhere. This kind of "follow the leaders" activity can not be dismissed as inconsequential; significant progress in the practical application of other's discoveries can be expected if the necessary resources are provided[redacted]

The Soviets have also reported the successful development of an "oil eating" micro-organism and are known to be involved in programs applicable to the microbiological leaching of scarce metals from ores and to medicine. Soviet emphasis on applied research was evident at a 1982 symposium held in Tallinn, where representatives from 36 Soviet institutes presented papers on plasmid research. The ability to incorporate recombinant DNA into plasmid vectors is

vital to applied research. Published research, however, can only suggest possible Soviet research directions and the potentials for application.[redacted] We believe that, with some possible military exception, they are similar to those of the West[redacted]

Because of the USSR's orientation toward applied research, it is unlikely that the current Soviet momentum in genetic engineering, and other biotechnologies, could sustain itself without anticipated, timely, and significant successes. Since Soviet research is government funded through various ministries, the totality of financial risk belongs to the government. Biotechnology research is highly speculative and costly. Despite the widely publicized international expectations surrounding biotechnology in general, we can expect the Soviets to maintain a conservative approach to risk taking. This is a major reason that we believe the Soviets will exploit available Western-developed, "off the shelf" genetic-engineering technology whenever possible. Perhaps to decrease its financial risk and to stimulate productivity, the Soviet Government is reported to have passed regulations in 1981 to provide for capitalist-like incentives.[redacted] Such an approach to R&D is a change in Soviet policy. The benefits probably would outweigh the risks of basic research, and commercial successes would drive new programs and expectations. The potential effects of such incentives on scientific productivity, even in the USSR, are self-evident.[redacted]

Resources Supporting Soviet rDNA Programs.[redacted] Certainly, funding is scaled depending on the prominence of the institute, the ministry involved, and the priority of assigned research programs. Western visitors have described some of the more prominent institutes as showplaces lavished with Western-acquired high-technology equipment, while some lesser institutes have been described as primitive.[redacted] Nevertheless, demonstrated Soviet growth and expansion in the field are indicative of priority and generous funding support[redacted]

Basic and applied genetic engineering and related research are carried out in at least 70 institutes and universities across the USSR. Some institutes appear to have specific, contributory tasks, such as enzyme preparation, whereas others carry out a more innovative and broadly based molecular genetics research program. The more sophisticated research is generally carried out in selected and older institutes with established expertise in contributing scientific disciplines such as biochemistry, microbiology, enzymology, and classical genetics. Exceptions are a few relatively recent institutes headed by dynamic, reputable scientists who have been able to assemble a nucleus of competent researchers. The participating research facilities are subordinate to a number of Soviet ministries and scientific academies including the Academy of Sciences, the Academy of Medical Sciences, the Academy of Agricultural Sciences, the Microbiological Industry, the Ministry of Health, the Ministry of Defense, and the Ministries of Education in the various Soviet federated and autonomous republics[redacted] This spectrum of affiliations would seem disadvantageous, even in a highly structured society. However, in the USSR, funding through separate ministries, each with some selfish motives, may actually fertilize healthy competition.[redacted]

Many Soviet researchers, who have gained prominence in genetic-engineering publications and who have acquired responsibility at their research facilities, received training in the West during the mid-to-late 1970s. The Soviets sent gifted scientists and students to laboratories and university programs in the West, including the United States. This "hands-on" training helped the startup of Soviet research efforts in this field immensely.[redacted] Based on the numbers of new names appearing in Soviet genetic

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engineering publications, it appears that training is being carried out expeditiously. A probable Soviet advantage has been its strength in biochemistry and the ability to focus promising individuals into its better training programs [redacted] particularly talented individuals, generally at the post-doctoral level, are sent to the technically advanced Soviet laboratories for extensive training ranging from months to several years. These individuals then form the nuclei of newly established research groups. This process can effectively broaden their scientific base, but we believe that these differing levels of skill will leave Soviet researchers vulnerable to obsolescence because evolutionary developments have been so characteristic in genetic engineering. At the basic science level, Soviet molecular biologists are, generally, fewer in number and of lesser quality than their Western counterparts. Some Soviet researchers are, however, as technically competent and innovative as the more progressive Western scientists. Overall, the USSR's thin base of researchers with recombinant DNA expertise will continue to be a major factor contributing to its technological lag when compared with similar Western efforts. [redacted]

Soviet genetic-engineering laboratories continue to be hampered by major dependence upon Western-produced equipment, instrumentation, reagents, enzymes, and numerous other critical items. The effects have been most pronounced on institutes with emerging research programs. Improvements in the acquisition and dissemination of necessary materiel have been only gradual. The Soviets have recognized this problem to be a rate-limiting factor and are moving toward greater self-sufficiency. The threat of technology transfer curtailments has also been a motivating factor. The indigenous support system for supplying the needs of their genetic engineering laboratories is still poorly developed. The phenomenon seen in the West with many small companies, each producing one or a few specialty items, has no counterpart in the USSR. In the near term, the Soviets at best will be able to provide their own biologicals (enzymes, bacterial strains, and plasmids) and generalized equipment and materials (centrifuges, microscopes, plastic ware, disposables, radioisotopes, gels, and reagents). High-technology instrumentation and some items needed in small quantities will continue to be imported. It is simply more economical to purchase than to produce these items. The Soviets recognize that the need for self-sufficiency in this regard is not compelling. The international network of suppliers is so extensive that even major efforts to curtail technology transfer would only impede Soviet research programs. [redacted]

Comparisons to US rDNA Research Efforts. Soviet research capability in genetic engineering has consistently lagged that of the United States. Overall, the Soviet research effort, particularly in applied research, is quantatively and qualitatively inferior to that of the United States. The Soviet's rapid catchup phase during the late 1970s has now placed them at least two years behind the United States. We believe this trend may continue indefinitely. Most of the fundamental discoveries and key innovations in applicable technology and methodology will occur in the United States, Western Europe, [redacted] The USSR is not expected to match the West in the quantity of commercially useful applications. Innovative research and rapid advancement, however, may occur in areas given special emphasis. The impact of Soviet commercial applications and foreign licensing of processes on international trade will be moderate at best. In the intermediate term (five to 10 years), most of the Soviet effort will probably be directed at solving internal economic problems and providing consumables for internal use. Since their safety and efficacy standards are probably less restrictive, the Soviets may be able to bring genetically engineered biologicals and pharmaceuticals on line sooner than comparable Western efforts. Because of the technology and engineering challenges involved with rDNA applications, an important rate-limiting factor will be their ability to scale up for mass production. Soviet production capabilities will most likely depend heavily on foreign technology transfer. Projections in this area have been characteristically outpaced by actual events [redacted]

In the United States, research talent has flowed from numerous public and privately funded universities into ever increasing small genetic engineering companies and, more recently, into major corporations. The incentives for personal and corporate financial gain

are the major driving force toward the introduction of engineered end-products. The breadth of the US effort is fueled by the availability of venture capital. Despite coordination efforts, the Soviet's applied research is significantly distant from their production industry. Incentives are not comparable; entrepreneurs are scarce. The Soviet system, beset by a cumbersome bureaucracy, must provide for all activities carried out within the structure of government-directed research and product development. Missing elements require the development of new industries or must be purchased abroad. Continued infusion of government funds is crucial to the Soviet research progress; this is likely only if anticipated goals are achievable. [redacted]

Soviet Military Implications. [redacted]

There are a broad range of potential defensive military applications. Among these are vaccines against militarily important diseases; superior chemical antidotes; CBW detection systems; recovery from ore of strategic metals such as uranium; nonfossil fuel production; biosynthesis of specialized lubricants; and production of special-purpose compounds such as plastics, pure chemicals, and friction-reducing coatings. Offensive military applications of genetic engineering might include the development of unique (difficult to detect, identify, and treat) antipersonnel CBW agents and toxins. Similar agents could be developed against crops, livestock, and military materiel. The development and exploitation of Soviet offensive capabilities would seriously threaten the United States. [redacted]

The Soviet military sector has access to the technology necessary to pursue military goals. Further, it can influence priorities, direct and fund its own rDNA research, and sponsor research in nonmilitary affiliated institutes. Military interests are most likely represented on the Interagency Scientific and Technical Council [redacted] Several Soviet papers published in the open literature at the Gamaleya Institute of Epidemiology and Microbiology, Moscow describe the property of aerosol stability being genetically engineered into *E. Coli*. If this interpretation is

[1] *Eschericia coli* is the most commonly used bacterial species in genetic-engineering research and is also a natural inhabitant of the human gut. [redacted]

correct, it would mean that the Soviets have a stable, aerosolizable, seemingly benign BW agent capable of producing a unique toxin.[redacted]

There are other research papers which have appeared in open scientific publications that, while appearing to represent legitimate research interests, also have obvious military potential.

- Transfer of a gene conferring antibiotic resistance from *E. Coli* to the causitive agent of cholera.

- Synthesis and cloning of an artificial gene for a sleep-inducing peptide. This research was carried out at the Institute of Bioorganic Chemistry in Moscow, one of the premier molecular genetics research establishments.[redacted] In addition to this peptide, the Soviets are studying others that are capable of varied effects such as inducing fear, exaggerated emotional responses, and lethal nervous system impairment.

- Development of "oil-eating" bacteria to consume lubricants or to attack fuel depots.

- Development of methyl-styrene (synthetic rubber) degrading bacteria.[redacted]

Soviet rDNA Technology Base Development

The key to the Soviet development of a technology base in genetic engineering was, and still is, the transfer of technology from the West. The USSR is years ahead of where it would have been without foreign technology. Since the late 1970s, the Soviets have expanded their rDNA technology base by coordinated planning, training, and retraining talented scientists at home and abroad, developing research facilities, methodically collecting information, and acquiring necessary equipment and materiel in the West. The US-USSR Microbiology Exchange Program during the 1970s facilitated rapport between scientists and provided the Soviets the knowledge needed to equip laboratories, establish research programs, and train scientists. Although applied research is the priority, the Soviets realize the need for developing and maintaining a strong basic research capability. The state of their technology base could not have been accomplished without decisiveness and adequate funding.[redacted]

Factors Affecting Soviet Technology Base Development. Genetic-engineering technology is dynamic and Soviet scientists cannot be expected to work in a vacuum. The traditional Soviet organizational structure—which isolates researchers from each other and from the ultimate product and which routinely withholds research goals from most bench scientists—hinders progress. For example, in the development of engineered micro-organisms for the extraction of metals from ores, molecular biologists would have to work closely with mineralogists and geologists. The Soviets appear to be effectively coordinating applied research with their industries through the auspices of the Interagency Scientific and Technical Council or other coordinating agencies. Soviet researchers need to collaborate because no institutes are self-sufficient in necessary materiel. Western research collaboration in this field is decreasing because of proprietary interests.[redacted]

Western scientific journals are available to the USSR and most are translated by the Ministry of Information Centers. Organizational stratification within the Soviet system tends to slow the information diffusion process. Because this science is so dynamic, the ministry must improve efforts to disseminate the information to all participating Soviet scientists in a timely manner. A restrictive information flow could rapidly isolate their scientists internationally and limit their expanding technology base [redacted]

The censorship of Soviet publications and security restrictions during personal interactions with foreign scientists threatens the international credibility of Soviet scientists. Because foreign scientific meetings and official exchanges offer a much higher information acquisition payoff than published research, the Soviets can be expected to expand their scientific foreign travel program to maintain pace [redacted]

A problem with the Soviet system that often results in long technological lag is its conservative avoid-risk approach. Incentives for developmental work are often too small to compensate for the risks involving a new technology. As a consequence, there is often an aversion to new technical solutions and processes. A continual infusion of government funds will be necessary to expand the technology base, to achieve some needed technological self-sufficiency, and to close the rDNA technology lag with the West. If the reported incentive program for applied research is successful and they are able to gain hard currency through commercial exports of consumer products and foreign licensing, the Soviets would be less conservative in financing the expansion of their rDNA technology base. In the meantime, we expect them to concentrate their resources and focus priorities towards adapting existing technology and continuously upgrading their capabilities. [redacted]

The USSR has sufficient, high-quality researchers and cooperation between institutes to be productive in this rapidly advancing science. A major shortcoming is their present bioengineering capability and their dependency on foreign equipment and materiel. Reverse engineering efforts and difficulties in duplicating purity of chemical reagents, enzymes, and specifications and tolerances of specialized laboratory equipment and instrumentation have resulted in delays in the application process. The impact has been most severe on lesser research programs, which are more dependent on Soviet and Eastern-Bloc made goods. The net effect is a dilution of the diversity of the technology base. Another major problem area is the status of production capabilities. In related fields, like pharmaceutical production and large-scale fermentation, the Soviets have limited capability and a poor record of accomplishment. There, they experience difficulties with production scale-up and quality control. We expect a similar trend in the more challenging bioengineering aspects of mass-producing recombinant DNA products. Genetically altered micro-organisms are often unpredictable and require careful monitoring during production. Scaling-up from laboratory quantities to thousands of liters used in industrial production involves sophisticated production technology and instrumentation. Given adequate priority the Soviets will probably solve these and other bioengineering problems. We believe that future Soviet technology transfer will be heavily directed toward developing indigenous industrial-scale production capabilities. Further, the Soviets can purchase the necessary equipment, if not complete production lines, in the international biotechnology market [redacted]

Technology Transfer

Character of Activities. The USSR is methodically collecting applicable information and materiel to broaden its genetic-engineering technology base. Methods include commercial purchases, scientific exchanges, exploitation of published literature, attendance at international meetings, diversions, misrepresentation of end users, and clandestine acquisition [redacted] The effort has been aided by the free flow of information and the international availability of materiel necessary to conduct this research. Generally, Western scientists have been willing to help further Soviet progress of this and other biological sciences [redacted]

[redacted]

[redacted]

Soviet workers have access to the extensive Western open literature, where descriptions of research initiatives, technical innovations, and methods are freely published. In addition to the ready availability of needed materiel, scientists have exchanged living microbial cultures and recombinant DNA vectors such as plasmids and phages. The availability of "gene libraries" has simplified the Soviet's basic research effort. In support of the Soviet acquisition process, individual agencies and even institutes have sometimes been permitted to bypass the cumbersome state organizations that manage foreign importation and have been allowed to deal directly with US and other suppliers. Additionally, there has been an extensive transfer of information through exchanges involving Soviet scientists and students and short private visits. Non-Soviet Warsaw Pact visits have also increased, and there is evidence of cooperation between the Soviets and Eastern Bloc countries in the collection and dissemination of information gleaned from those visits. This "hands-on" training is an exceptionally effective method of technology transfer [redacted]

Many Western companies are cooperating with the USSR's bid to develop a sound genetic engineering technology base including production capabilities. Numerous Western scientific and industrial firms are entering into cooperative agreements with the Soviets to provide sophisticated Western equipment applicable to genetic-engineering pursuits. Several companies are said to be providing seminars and training by scientific and technical experts on location in the Soviet Union. Instructions include the use of actual equipment. The purpose appears to be to encourage the Soviets to further purchase and use newly developed equipment. The effect is that the Soviets are not only obtaining high technology but are also learning to use it. We believe that acquired Western technology has been largely responsible for the status of the Soviet's genetic engineering technology base and the rapid expansion of their basic and applied research capability [redacted]

Consequences of US Technology Transfer-Control Efforts. Data, equipment, and materiel associated with genetic-engineering research and its applications have been subject to some US export restrictions as part of the overall reduction in the level of trade between the United States and USSR. This US effort was reported to have slowed the pace of their research and acquisition efforts. In response, the Soviets have initiated measures to increase their self-sufficiency and to lessen their former dependency on US technology. Although Soviet scientists prefer US-made equipment and supplies, access to US suppliers is not critical to the survival of Soviet research programs or their technology base development. Everything needed is available [redacted] via foreign subsidiaries of third-party

countries. Only a concerted measure by all non-Communist, research participating countries, could significantly slow Soviet efforts. Certain West European countries, [redacted] probably would not support such a measure unless Soviet offensive military intentions could be clearly demonstrated. The net effect of a singular US embargo would be the loss of an economic market [redacted]

Anticipated Soviet Trends. The Soviets perceive genetic engineering as an emerging technology with broad economic as well as military implications. Because of their lag behind the West, they accept the fact that most of their own rDNA programs will continue to rely on materiel and ideas supplied by others. To this end, they will continue to expand their network of foreign suppliers. They will exploit the foreign open literature and encourage their scientists to maintain communication with international leaders in the biotechnology field. Collection efforts by the KGB and GRU can be expected to focus on acquisition of an ever increasing level of US and Western proprietary rDNA research and technological innovations that are not licensed for export [redacted]

The extent and success of Soviet efforts to achieve self-sufficiency in this technology will be largely influenced by technology transfer policies adopted by the United States and other cooperating nations. In the absence of trade restrictions, the Soviets are expected to limit themselves to producing common items for everyday use. They prefer to purchase abroad sophisticated instrumentation and equipment and low-volume items because it is simply more expedient to purchase than produce. Related bioengineering skills will continue to lag, and the Soviets will attempt to acquire foreign production technology. Similar patterns of Soviet reliance have been observed in the initial R&D phases of other highly technical endeavors such as fine chemicals production, microelectronics, computers, and pharmaceutical production. If they are confronted with effective Western technology transfer restrictions, which we believe unlikely, they will slow their research and place a priority on acquiring necessary self-sufficiency. The effect would be that they would further fall behind the West in the near and intermediate term (two to 10 years). The Soviets probably would not alter their national applied genetic-engineering research objectives as long as they perceive them to remain achievable [redacted]

Analysis of Soviet Success Potential

Applicable Technical Endeavors. Credible Soviet spokesmen have publicly indicated that enterprises judged important to the USSR, such as crop-plant productivity, livestock breeding, diagnosis of hereditary impairments, prevention of infectious diseases, and obtaining biologically active substances, are all likely to benefit from genetic engineering. Actual Soviet achievements will be influenced by their technology base development and central directives, which attach priorities to the various national sectors for which genetic engineering could be expected to have

an impact. These include agriculture, energy, the chemical industry, the Soviet military, and the applied biomedical field. Military requirements, domestic needs, the need for export earnings, and the desire for international scientific recognition together will influence these priorities. [redacted]

Commercial Implications. Although the Soviets clearly want domestic benefit from this technology, we also believe that they intend to expand into the international commercial market. Likely near-term candidates for export are commodity chemicals and further licensing of industrial fermentation products and processes. Further successes will depend on their ability to engineer organisms with new or enhanced capabilities. We believe that the Soviets have these capabilities and that they can be moderately successful economic competitors. However, they will not be able to match the West in diversity of marketable products. A Soviet advantage may be their ability to direct attention and focus resources at specific projects with high-payoff potential. This could result in a more rapid developmental phase in product evolution. Further, the government's ability to stabilize and control long-term prices would facilitate foreign market entry. To be successful, the Soviets will have to improve their marketing techniques, guarantee deliveries, and attain required quality-control standards. The last two are potential rate-limiting factors [redacted]

We expect Soviet agriculture to receive considerable attention. Dependency on foreign grain, unreliable crop output, marginally productive agricultural areas, and losses to plant pests are preeminent domestic concerns. Genetic engineering offers potential alternatives in all of these concerns. The application of rDNA techniques to plant cells is currently at infancy worldwide. Plant genetics at the molecular level is poorly understood, but some progress is being made. Altering specific genetic traits for environmental factors—for example, heat and cold resistance—requirements of soil quality and pH, and protection against crop pests and diseases are thought to be achievable. Increasing plant yield involves numerous complex genetic codes; major successes are not anticipated for 10 to 20 years or more. Long lag periods are characteristic of new developments in crop productivity. The Soviets can enter this aspect of the genetic-engineering field on the ground floor, as they have considerable expertise in plant biochemistry, plant physiology, and plant genetics. Breakthroughs in livestock farming, facilitated by development of hormones, protein supplements, enzymes, new antibiotics, and superior vaccines against animal diseases, will occur during the 1980s. [redacted]

High success potential is expected in the area of biomedical applications, particularly public health. This area is currently receiving worldwide attention. We expect the Soviets not only to exploit the West's research lead in this area but also to develop original useful medical products. The emphasis will be on superior vaccines and biologically active proteins, such as insulin, interferon, hormones, and enzymes. Some success in these areas has already been achieved; further success is imminent [redacted]

We expect the energy and chemical industries to benefit from genetic-engineering technology. Soviet interest is evident in commodity chemicals, large-scale fermentation, microbial leaching of metals from ores, biodegradation, and pollution control. The potential for developing biological catalysts for the chemical industry exists. Although the Soviet researchers have shown an interest in genetic-engineering approaches to synthetic fuel development and enhanced petroleum recovery, we do not expect energy applications to become a near-term Soviet research priority. The Soviets have oil and also export large quantities of gas. They have invested heavily in conventional recovery methods, but will continue to research genetic-engineering applications in energy production primarily to avoid technological surprise and to protect their long-term export position [redacted]

Military Implications. Because the Soviet military has substantial influence and technical resources, their interest in genetic-engineering applications will directly affect national objectives and priorities. We believe the military will exploit Soviet research developments. The spectrum of potential defensive and

[redacted]

offensive military applications has been discussed previously. Soviet military interest is motivated by the potential for battlefield and strategic advantage and the threat of technological surprise in this area. Western military-related applied rDNA research for defensive purposes is currently minor in scope. Assuming high military priority, the Soviets can move ahead of the West in useful military applications. [redacted]

Projected Soviet R&D Outcomes. Future Soviet genetic-engineering advancements and their application to the solution of practical problems will be influenced by the priorities they establish, their technical skill, and the technological feasibility of what is being attempted. [redacted]

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Exemptions: (b)(3), (b)(1)

Special Analysis

USSR: Genetic Engineering

The USSR is promoting genetic engineering, a method by which genetic material can be isolated, manipulated, and introduced into cells to alter their characteristics. Moscow is emphasizing research in biotechnology, with eventual applications in medicine, agriculture, and industry. The Soviets see genetic engineering as the most immediately promising area of biotechnology, and they are using every available mechanism to acquire the more advanced technology of the West. Genetic engineering has both military and civilian applications. [redacted]

The progress of Soviet genetic engineering has been made possible in part by the acquisition of Western laboratory equipment and expertise. US export restrictions on genetic engineering-related data, equipment, and materials reportedly have slowed research, but the Soviets have resorted to clandestine acquisition when legal means have been denied them. Moreover, Moscow is now able to purchase these resources from Western Europe, [redacted] and foreign subsidiaries of US companies [redacted]

There are fewer molecular biologists in the USSR than in the West. By concentrating on basic sciences, however, the Soviets have mastered existing technology. They are capable of innovative research and technological development in areas to which they give special emphasis [redacted]

Research Facilities

Basic and applied genetic engineering and related research are carried out at more than 75 Soviet facilities. The more complex research is generally conducted by institutes with long established expertise in biochemistry, enzymology, and classical genetics. A few recently established institutes also are involved [redacted]

These research facilities are subordinate to the Academy of Sciences, the Ministry of Health, the Microbiological Industry, the Ministry of Defense, or universities throughout the country. An Interagency Scientific and Technical Council subordinate to the Council of Ministers and the party Central Committee was established in 1981 to organize and direct the research [redacted]

continued

[redacted]

[redacted]

(b)(1)
(b)(3)

USSR: Genetically Engineered Biological Warfare

The USSR's biological warfare program is attempting to develop agents whose characteristics would not be identifiable using current Western technology, thus complicating and possibly precluding medical treatment of infected troops and civilians [redacted]

[redacted] This is the first direct evidence the Soviets are using genetic engineering for military research on specific micro-organisms. Research [redacted] permits refinement of genetic engineering laboratory techniques and provides a model [redacted] Expertise gained from this research may result in the production of new or altered biological agents that could be difficult to identify and treat [redacted]

[redacted]